Appendix N. Candidate vital signs comments.

Table 1. Comments received about the candidate vital signs from the 44 respondents who ranked vital signs.

National Framework Level 1 Category	Monitoring question	Vital Sign	Comments
Air and Climate	Are climate associated ecotones changing through time?	elevational vegetation boundaries (e.g. treeline)	All these are good integrative measures but I think they would be tough to define.
Air and Climate	Are climate associated ecotones changing through time?	elevational vegetation boundaries (e.g. treeline)	May not be a resource at risk in some areas?
Air and Climate	Are climate associated ecotones changing through time?	elevational vegetation boundaries (e.g. treeline)	Longer growing season, alpine areas will shrink, new pops move in, existing ones move out or are lost altogether.
Air and Climate	Are climate associated ecotones changing through time?	elevational vegetation boundaries (e.g. treeline)	Comm. Comp. may be more sensitive than ecotone
Air and Climate	Are climate associated ecotones changing through time?	estuarine vegetation boundaries	Estuaries too dynamic to be a good indicator of this stressor.
Air and Climate	Are climate associated ecotones changing through time?	estuarine vegetation boundaries	May not be climate related
Air and Climate	Are climate associated ecotones changing through time?	freshwater vegetation boundaries	Same as above.
Air and Climate	Are climate associated ecotones changing through time?	freshwater vegetation boundaries	may not be climate related.
Air and Climate	Are climate associated ecotones changing through time?	intertidal boundaries	Doesn't apply to all parks.
Air and Climate	Are climate associated ecotones changing through time?	intertidal boundaries	If associated with sea level change.
Air and Climate	How are snowpack dynamics changing over time?	snowpack depth	All the snow measurements seem critical to ecosystem functioning and straight forward to measure although you'd need to define how many time to monitor snow depth.
Air and Climate	How are snowpack dynamics changing over time?	snowpack depth	Need water content of pack as well
Air and Climate	How is cave air flow (quantity and quality) changing through time?	mineral dissolution and accretion	mineral dissolution/accrestion is not only controlled by air flow

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Air and Climate	How is sea level and ocean temperature changing?	intertidal zonation	If local coastal uplift/subsidence processes well understood.
Air and Climate	How is sea level and ocean temperature changing?	intertidal zonation	More work to measure than sea level which seems like it would be an easy indicator.
Air and Climate	How is sea level and ocean temperature changing?	ocean temperatures	Complex process not well understood.
Air and Climate	How is sea level and ocean temperature changing?	Sea level (max & min tides)	If local coastal uplift/subsidence processes well understood.
Air and Climate	How is sea level and ocean temperature changing?	Sea level (max & min tides)	Seems really important and straight forward to measure.
Air and Climate	What are status and trends in fog?	air temperature	alone, it won't tell you much about fog distribution. need ocean temps and dewpoint temps.
Air and Climate	What are status and trends in fog?	air temperature	Data that are regularly collected already.
Air and Climate	What are status and trends in fog?	fog dynamics and distribution	Much harder to measure and what do you use as comparison?
Air and Climate	What are status and trends in fog?	Redwood growth and metabolism	These are likely to be influence by lots of other things besides changes in fog, so not a good indicator of that.
Air and Climate	What are status and trends in fog?	Redwood growth and metabolism	difficult to measure, and could be affected by a number of factors other than fog.
Air and Climate	What are status and trends in pollutants (e.g. ozone, N, S, particulates)?	acid deposition	only some pollutants result in acid deposition
Air and Climate	What are status and trends in pollutants (e.g. ozone, N, S, particulates)?	amphibians	It seems like there are so many things that could be causing amphibian declines that it is impossible to separate out pollutants through amphibians
Air and Climate	What are status and trends in pollutants (e.g. ozone, N, S, particulates)?	amphibians	Many complicating factors (e.g. diseases) drive amphibian changes.
Air and Climate	What are status and trends in pollutants (e.g. ozone, N, S, particulates)?	aquatic species composition	Not enough detail – what types of aquatic species.
Air and Climate	What are status and trends in pollutants (e.g. ozone, N, S, particulates)?	aquatic species composition	So many variables, thus making clear connections difficult.
Air and Climate	What are status and trends in pollutants (e.g. ozone, N, S, particulates)?	aquatic species composition	Too complex to tease out air pollution as causal.
Air and Climate	What are status and trends in pollutants (e.g. ozone, N, S, particulates)?	lichens	Are good for air quality.

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Air and Climate	What are status and trends in pollutants (e.g. ozone, N, S, particulates)?	pollutants	Measuring pollutants directly may be the best way to answer this monitoring question?
Air and Climate	What are status and trends in pollutants (e.g. ozone, N, S, particulates)?	pollution sensitive trees	JP sensitive, but not necessarily at risk
Air and Climate	What are status and trends in pollutants (e.g. ozone, N, S, particulates)?	pollution sensitive trees	Again there could be multiple causes.
Air and Climate	What is timing and duration of key climate-related phenological events?	bird breeding	Many complicating factors makes this a weak indicator.
Air and Climate	What is timing and duration of key climate-related phenological events?	bird breeding	For all - choice of which species to monitor seems critical to success
Air and Climate	What is timing and duration of key climate-related phenological events?	invertebrate hatching	Would pollinator arrival/abundance be another potential vital sign here?
Air and Climate	What is timing and duration of key climate-related phenological events?	invertebrate hatching	Many complicating factors makes this a weak indicator.
Biological Integrity	What are status and trends in focal species?	keystone birds	'Keystone' should be defined
Biological Integrity	What are status and trends in focal species?	keystone birds	* PIF has identified a sweet of focal species at national and regional levels, getting away from single species management.
Biological Integrity	What are status and trends in focal species?	keystone birds	Don't get me started on keystone species - these can be debated ad infinitum.
Biological Integrity	What are status and trends in focal species?	keystone birds	For all -choice of which species to monitor seems critical for success
Biological Integrity	What are status and trends in focal species?	keystone birds	It's fine to measure any of the focal species to ascertain their population trends but I'm always skeptical of using focal species as indicators of other parameters as their utility seems to vary so much from one system to the next.
Biological Integrity	What are status and trends in focal species?	keystone birds	Measurable, comprehensive
Biological Integrity	What are status and trends in focal species?	keystone fish	Measurable, comprehensive
Biological Integrity	What are status and trends in focal species?	keystone fish	Could be affected by changes at a large distance from focal area.
Biological Integrity	What are status and trends in focal species?	keystone mammals	Measurable, comprehensive
Biological Integrity	What are status and trends in focal species?	keystone marine species (e.g. bull kelp)	Could be affected by changes at a large distance from focal area.

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Biological Integrity	What are status and trends in focal species?	keystone marine species (e.g. bull kelp)	Measurable, comprehensive
Biological Integrity	What are status and trends in focal species?	keystone plants (e.g. Aspen, whitebark pine)	Measurable, comprehensive + interpretable
Biological Integrity	What are status and trends in focal species?	rare birds (e.g. brown pelican)	Rare species aren't good indicators because they usually lack the numbers to be ubiquitous in the environment. Plus, when they respond to change, they may just go away before you have a chance to do anything.
Biological Integrity	What are status and trends in focal species?	rare birds (e.g. brown pelican)	Measurable, at risk, sensitive
Biological Integrity	What are status and trends in focal species?	rare birds (e.g. brown pelican)	Again these all depend on whether you're focusing on the rare species for their own sake or as an indicator of other species. They tend to be lousy indicators of rht latter.
Biological Integrity	What are status and trends in focal species?	rare birds (e.g. brown pelican)	The BRPE is not rare
Biological Integrity	What are status and trends in focal species?	rare birds (e.g. brown pelican)	It really depends on the species - regarding how relevant.
Biological Integrity	What are status and trends in focal species?	rare fish (e.g. salmonids)	Measurable, at risk, sensitive
Biological Integrity	What are status and trends in focal species?	rare mammals (e.g. stellar's sea lion)	Measurable, at risk, sensitive
Biological Integrity	What are status and trends in focal species?	rare plants	Measurable, at risk, sensitive
Biological Integrity	What are status and trends in focal species?	sensitive birds (e.g. common murres)	Measurable, at risk, sensitive
Biological Integrity	What are status and trends in focal species?	sensitive birds (e.g. common murres)	I'm not sure if you're using sensitive here in the in the context or in the context of the fact that they are sensitive to stressors.
Biological Integrity	What are status and trends in focal species?	sensitive fish (e.g. flat fish)	Measurable, at risk, sensitive
Biological Integrity	What are status and trends in focal species?	sensitive marine species	Measurable, at risk, sensitive
Biological Integrity	What are status and trends in focal species?	sensitive plants	Measurable, at risk, sensitive
Biological Integrity	What are status and trends in focal taxa groups?	amphibians	For all listed focal taxa groups, it is unclear how you would get an unbiased assessment of all species within groups.
Biological Integrity	What are status and trends in focal taxa groups?	Bryophytes and lichens	the above-mentioned problem is intensified here - i.e. do you plan to get assessments of tree canopies.
Biological Integrity	What are status and trends in focal taxa groups?	fish assemblages	The IBI has been shown to be one of the more effective indicator systems for aquatic habitats.
Biological Integrity	What are status and trends in focal taxa groups?	freshwater mussels	Don't know enough.

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Biological Integrity	What are status and trends in focal taxa groups?	insects	Hard to measure/assess
Biological Integrity	What are status and trends in focal taxa groups?	insects	Not easily identified
Biological Integrity	What are status and trends in focal taxa groups?	insects	Need to investigate this!
Biological Integrity	What are status and trends in focal taxa groups?	land birds	Now we are taking - a sweet of focal species, identified through a science-based process. Are there comprehensive plans for these other important taxa?
Biological Integrity	What are status and trends in focal taxa groups?	land mammals	Usually not too sensitive to change, except for on islands.
Biological Integrity	What are status and trends in focal taxa groups?	marine algae	Doesn't apply to all parks.
Biological Integrity	What are status and trends in focal taxa groups?	marine invertebrates	Doesn't apply to all parks.
Biological Integrity	What are status and trends in focal taxa groups?	marine mammals	Doesn't apply to all parks.
Biological Integrity	What are status and trends in focal taxa groups?	mycorhhizae	Better measures of productivity
Biological Integrity	What are status and trends in focal taxa groups?	mycorhhizae	You cannot accurately quantify this without doing above/and below ground studies and incorporating molecular diversity assessments.
Biological Integrity	What are status and trends in focal taxa groups?	mycorhhizae	Hard to measure/assess
Biological Integrity	What are status and trends in structure, function, and composition of focal communities?	cave entrance community	For all - are you referring to all-taxa inventories? You will not be able to get accurate assessment of microbial members in each of these communities. This is especially problematic in cave ecosystems where microorganisms are key players in productivity
Biological Integrity	What are status and trends in structure, function, and composition of focal communities?	cave species	Prokaryotic communities drive cave ecosystems - but unclear how
Biological Integrity	What are status and trends in structure, function, and composition of focal communities?	song bird communities	I'm assuming this if for resident populations.
Biological Integrity	What are status and trends in structure, function, and composition of focal communities?	special botanical areas (e.g. Little Bald Hills, Puccinellia springs)	Not antipitatory, but I feel an obligation to monitor these regardless of their ability to being a vital sign.

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Biological Integrity	What are the long term trends in the predominant habitat types?	cover of habitat types	Seems like a fairly easy thing to measure with current technologies and a good indicator of changes.
Biological Integrity	What are the long term trends in the predominant habitat types?	vegetation dynamics	Exceedingly complicated process not well understood – better as a research question, not a monitoring tool, will result in little useful information for changing management practices.
Biological Integrity	What are the long term trends in the predominant habitat types?	vegetation dynamics	Much more vague to measure.
Biological Integrity	What are the status and trends of biotoxin accumulation?	biotoxin accumulation in predators	A better indicator would be to measure the toxin itself. Waiting for it to bioaccumulate or biomagnify means that it may already be having an impact.
Biological Integrity	What are the status and trends of biotoxin accumulation?	biotoxin accumulation in predators	Fish? Predatory insects?
Biological Integrity	What are the status and trends of biotoxin accumulation?	biotoxin accumulation in predators	biotoxin accumulation I predators doesn't reveal the source population. I feel monitoring from the bottom of the food chain up is the most benificial.
Biological Integrity	What are the trends in diseases or parasites (including forest insects) through time?	animal carcasses	Vital signs that measure disease directly would be more relevant.
Biological Integrity	What are the trends in diseases or parasites (including forest insects) through time?	animal carcasses	I laughed when I saw this. Not very anticipatory, is it?
Biological Integrity	What are the trends in diseases or parasites (including forest insects) through time?	animal carcasses	Examination of dead animals will not permit identification of disease reservoir or management of disease spread/vector control, etc.
Biological Integrity	What are the trends in diseases or parasites (including forest insects) through time?	diseased marine invertebrates	You will not ID vectors/ or carriers. Some diseased animals may be asymptomatic.
Biological Integrity	What are the trends in diseases or parasites (including forest insects) through time?	marine mammal behavior	extremely difficult to correlate behavioral changes with disease
Biological Integrity	What are the trends in diseases or parasites (including forest insects) through time?	plant mortality	Cause of mortality must be indicated
Biological Integrity	What are the trends in diseases or parasites (including forest insects) through time?	plant mortality	Examination of dead plants will not permit identification of disease reservoir or management of disease spread/vector control, etc.

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Biological Integrity	What are the trends in diseases or parasites (including forest insects) through time?	plant mortality	Pest “complexes” difficult to interpret
Biological Integrity	What are the trends in diseases or parasites (including forest insects) through time?	plant mortality	Plants could have died from all sorts of causes.
Biological Integrity	What are the trends in distribution and abundance of non-native species through time?	non-native diseases	Depends on disease, vector and host
Biological Integrity	What are the trends in distribution and abundance of non-native species through time?	non-native diseases	Detection of non-native diseases can be extremely difficult since you are often looking for pathogens that are not known.
Biological Integrity	What are the trends in distribution and abundance of non-native species through time?	non-native diseases	Important to monitor spread of some exotic species but to target those that are most invasive.
Biological Integrity	What are the trends in distribution and abundance of non-native species through time?	non-native invertebrates	Non-native role in nutrient cycling and other major ecosystem function important
Biological Integrity	What are the trends in distribution and abundance of non-native species through time?	non-native plants	This vital sign may also address questions about disturbance and human use?
Biological Integrity	What are the trends in distribution and abundance of non-native species through time?	non-native plants	It's hard not to be biased in this.
Biological Integrity	What are the trends in pollinators?	pollinator abundance	abundance, distribution and movement all seem crucial to address.
Biological Integrity	What are the trends in pollinators?	pollinator abundance	You can measure pollinators but it’s impossible to determine if lack of pollinators is affecting pollination without doing hand pollination tests so monitoring pollinators seems to me a waste of time.
Ecosystem Pattern and Processes	How are connectivity, fragmentation, and level of park "insularity" changing with land use change in and around the parks?	land cover	What is this?
Ecosystem Pattern and Processes	How are connectivity, fragmentation, and level of park "insularity" changing with land use change in and around the parks?	land cover	I couldn’t get the cursor to appear in the line above. I think that some measure of insularity is important but need to remember that what is insular depends on the scale of the organism.

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Ecosystem Pattern and Processes	How are connectivity, fragmentation, and level of park "insularity" changing with land use change in and around the parks?	land use	How does this differ from land use?
Ecosystem Pattern and Processes	How are connectivity, fragmentation, and level of park "insularity" changing with land use change in and around the parks?	landscape pattern	What does land pattern mean? Too vague
Ecosystem Pattern and Processes	How are connectivity, fragmentation, and level of park "insularity" changing with land use change in and around the parks?	road density	Use a better road effects metric than density. And consider traffic volume.
Ecosystem Pattern and Processes	How are connectivity, fragmentation, and level of park "insularity" changing with land use change in and around the parks?	road density	Could also use WUI distance/lot density?
Ecosystem Pattern and Processes	How are ocean and nearshore processes changing through time?	nearshore currents	Complex process, results may be misleading.
Ecosystem Pattern and Processes	How are ocean and nearshore processes changing through time?	Sea level (max & min tides)	As long as local subsidence and uplift processes understood.
Ecosystem Pattern and Processes	How are ocean and nearshore processes changing through time?	waves	Complex process, results may be misleading.
Ecosystem Pattern and Processes	What are the status and trends in anthropogenic disturbance?	human disturbance dynamics-lacustrine	How would this vital sign be measured?
Ecosystem Pattern and Processes	What are the status and trends in anthropogenic disturbance?	human disturbance dynamics-lacustrine	For all below - not sure how you would quantify human disturbance
Ecosystem Pattern and Processes	What are the status and trends in natural disturbance events (e.g. fire, floods)?	lacustrine (lake) disturbance dynamic	Doesn't apply to all parks.
Ecosystem Pattern and Processes	What are the status and trends in natural disturbance events (e.g. fire, floods)?	lacustrine (lake) disturbance dynamic	Although reference data may be lacking, I think these are important vital signs
Ecosystem Pattern and Processes	What are the status and trends in natural disturbance events (e.g. fire, floods)?	lacustrine (lake) disturbance dynamic	Have no idea how would track this, vague.

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Ecosystem Pattern and Processes	What are the status and trends in natural disturbance events (e.g. fire, floods)?	marine disturbance dynamics	Have no idea how would track this, vague.
Ecosystem Pattern and Processes	What are the status and trends in natural disturbance events (e.g. fire, floods)?	riverine disturbance dynamics	Have no idea how would track this, vague.
Ecosystem Pattern and Processes	What are the status and trends in natural disturbance events (e.g. fire, floods)?	subterranean disturbance dynamics	Have no idea how would track this, vague.
Ecosystem Pattern and Processes	What are the status and trends in natural disturbance events (e.g. fire, floods)?	terrestrial disturbance dynamics	Have no idea how would track this, vague.
Geology and Soils	Have rates, extent, location, or types of erosional and depositional processes changed?	gully formation	This seems to be lacking in scale.
Geology and Soils	Have rates, extent, location, or types of erosional and depositional processes changed?	sheet erosion	sheet erosion is gradual and (as I understand it) very difficult to measure
Geology and Soils	What are status and trends in soils?	sheet erosion	This is an erosion question
Geology and Soils	What are status and trends in soils?	sheet erosion	sheet erosion is gradual and (as I understand it) very difficult to measure
Geology and Soils	What are status and trends in soils?	soil biota	The microbial community are the key soil biota - difficult to measure w/o expensive molecular techniques
Geology and Soils	What are status and trends in soils?	soil compaction	Localized, probably doesn't affect large areas.
Geology and Soils	What are status and trends in soils?	soil fertility	Vague – how do you define fertility?
Geology and Soils	What are status and trends in soils?	topsoil integrity	How do you define integrity? Too vauge.
Geology and Soils	What are status and trends in soils?	topsoil integrity	Not sure what this means
Geology and Soils	What are the status and trends in subterrannean geologic processes?	cave wall fracture and collapse	Cave collapse could be due to other factors. Seems necessary to also examine surface changes (indicative of subterrannean processes) in geothermal features (i.e. in Lassen).
Geology and Soils	What are the status and trends in subterrannean geologic processes?	mineral dissolution and accretion	Mineral dissolution/accretion is also greatly influenced by biotic processes. It is unclear how you would separate biotic vs abiotic effects or whether you would need to.
Geology and Soils	What is the effusion rate of geothermal groundwater into the surface environment?	geothermal groundwater chemistry	Chemistry is controlled by biotic and abiotic factors, and not limited to effusion rate.

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Human use	What are status and trends in human impacts near sensitive plant and animal populations and habitats?	cave formations	Unclear
Human use	What are status and trends in human impacts near sensitive plant and animal populations and habitats?	cave formations	It may be better to measure human impacts directly instead of inferring them from species response, which may be confounded by other factors?
Human use	What are status and trends in human impacts near sensitive plant and animal populations and habitats?	marine mammal behavior	I don't see how this would make sense in the above question.
Human use	What are status and trends in human impacts near sensitive plant and animal populations and habitats?	threatened and endangered species	This total doesn't make sense. "What are the status and trends of threatened and endangered species near sensitive plant and animal populations?"
Human use	What are status and trends in human impacts near sensitive plant and animal populations and habitats?	tide pool condition	vague - unclear what is meant by condition
Human use	What are status and trends in human impacts near sensitive plant and animal populations and habitats?	wildlife migration	Maybe add - human-wildlife interactions? Or wildlife behavior? (Are fishers begging for food in campgrounds? If Whiskeytown has 5 mountain lion attacks this year, what does that mean?)
Human use	What are status and trends in human impacts near sensitive plant and animal populations and habitats?	wildlife migration	is it well established how human impacts affect migration?
Human use	What are the trends in harvesting of park resources?	commercial fishing	Mostly harvesting non-natives here.
Human use	What are the trends in harvesting of park resources?	commercial gathering (e.g. edible mushrooms)	nearly impossible to get accurate assessments
Human use	What are the trends in harvesting of park resources?	populations prone to poaching (e.g. Roosevelt elk)	Difficult to measure?
Water	What are status and trends in ground waters?	groundwater contaminants	choice of what contaminants to measure are key -biological/nonbiological?
Water	What are status and trends in pollutants (chemicals, nutrients, effluents, and trash)?	Chlorophyll	rises in chlorophyll can be due to factors other than increases in N and P
Water	What are status and trends in pollutants (chemicals, nutrients, effluents, and trash)?	Chlorophyll	I'm not sure what this tells you.

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Water	What are status and trends in pollutants (chemicals, nutrients, effluents, and trash)?	coliform bacteria	be sure to quantify fecal coliforms (not just total)
Water	What are status and trends in pollutants (chemicals, nutrients, effluents, and trash)?	marine mammals with oil or attached debris	This made me laugh for some reason.
Water	What are status and trends in pollutants (chemicals, nutrients, effluents, and trash)?	marine mammals with oil or attached debris	Marine mammals (except for otters) not affected severely by oiling and often tough to determine if are oiled.
Water	What are status and trends in pollutants (chemicals, nutrients, effluents, and trash)?	pollutants inorganic	Too vague
Water	What are status and trends in pollutants (chemicals, nutrients, effluents, and trash)?	turbidity	More of an indicator of erosion.
Water	What are status and trends in pollutants (chemicals, nutrients, effluents, and trash)?	water birds	Complicating disease factors, not an easily monitored indicator of all pollutants.
Water	What are status and trends in pollutants (chemicals, nutrients, effluents, and trash)?	water birds	Better to monitor the chemistry than the birds since they could be responding to something else.
Water	What are status and trends in subterranean water and ice?	cave aquatic species composition	The dominant aquatic species in caves are prokaryotes - do you really intend to get diversity estimates of prokarytic communities?
Water	What are status and trends in subterranean water and ice?	cave water contaminants	choice of what contaminants to measure are key -biological/nonbiological?
Water	What are status and trends in surface waters?	springs	Particularly flow.
Water	What are status and trends in surface waters?	surface water chemistry	Seems like the same as above
Water	What are status and trends in surface waters?	surface water contaminants	choice of what contaminants to measure are key -biological/nonbiological?
Water	What are status and trends in surface waters?	surface water contaminants	How does this differ from contaminants?
Water	What are status and trends in surface waters?	surface water flow	Seems like monitoring streams and pools would be easier.